

Ref. No.	$-kT^2$.	$V-V'-v'$.	t .	$\frac{k(V-V'-v')}{-(U-u')}$.
0	-263	-394	+0.3	+655''
1	+13	-148	+0.1	+17
2	+62	-198	+0.2	-30
3	-31	-168	+0.1	+8
4	+115	+7	0.0	+2
5	-38	+163	-0.2	+39

The large value in the first line of the last column shows that about one-third of the Sun was visible at Babylon at the maximum phase of the eclipse of -1069 June 20.

The equations of condition resulting from the other five eclipses are :

$$\begin{aligned}
 -73 s_F + 13 s_L &= +17'' \\
 -59 s_F + 62 s_L &= -30 \\
 -54 s_F - 31 s_L &= +8 \\
 -45 s_F + 115 s_L &= +2 \\
 +23 s_F - 38 s_L &= +39
 \end{aligned}$$

In some cases the right-hand sides are less than the difference of semi-diameters. A least-squares solution gives $s_L = -0''.18$, $s_F = -0''.05$; but these quantities are less than the probable errors.

The eclipse of Agathocles -309 Aug. 15 is central about fifty miles north of Syracuse. The figures are not reproduced here.

The equation of condition for the eclipse of -1062 shows that, with Hansen's position of the node, totality, even in the neighbourhood of Babylon, is impossible without a large increase of the secular acceleration.

On the Value of Ancient Solar Eclipses. By P. H. Cowell.

In *Ast. Nach.*, No. 3682, Professor Newcomb argues against the corrections to the three lunar elements, viz. the mean longitude and the longitude of perigee and node, based by Oppolzer and Ginzel on ancient solar eclipses. These corrections, as Professor Newcomb points out, are incompatible with modern observations and with theory, and I, like Professor Newcomb, believe them to be erroneous.

In the opening paragraphs of the paper referred to, Professor Newcomb lays down that "no attempt should be made to determine the motion either of the perigee or node from ancient eclipses" on the ground that their centennial motions have been settled by the accordance of modern observation with theory to within limits of error that would have no "appreciable effect on the paths of ancient eclipses." Professor Newcomb, however, ignores the possibility of errors in the secular variations. Now

these secular variations cannot be determined to within 5'' by modern observations, and the theory is certainly not above suspicion. No theoretical values have to my knowledge been published since Hansen's, who, in the case of the mean longitude, gave the erroneous value of 12''.

Now any error in the assumed value of g , the mean anomaly, introduces into the Moon's tabular longitude an error $\frac{1}{9} \cos g$ times the same amount. Probably, therefore, the secular term in the position of the perigee cannot be determined from ancient eclipses with an accuracy much superior to that resulting from modern observations.

Hansen's secular term in the longitude of the node, however, I believe to be erroneous by over 4'', corresponding to an error of nearly one degree in the earliest eclipses. Modern observations cannot criticise this correction, and the objection to it is wholly theoretical.

Later on in the paper referred to, Professor Newcomb raises the question, "To what extent, if at all, are we justified in determining the secular acceleration of the Moon from the supposed solar eclipses recorded by ancient historians?" When we examine Professor Newcomb's distrust of ancient solar eclipses, we find it is mainly, if not entirely, due to the fact that the eclipse of Xerxes, in the spring of the year of Salamis, cannot be identified at all, and that in the eclipse of Thales (—584) modern values of the secular acceleration make the central line end to the west of Asia Minor. Hence Professor Newcomb concludes that ancient eclipses, purporting to be total, cannot safely be assumed to have been so. I submit that the true inference is that ancient eclipses, when described by Herodotus or other historians born, as in the case of the eclipse of Thales, a hundred years after the event described, may be rejected. Herodotus's reputation for accuracy is, I believe, confined to the description of events and customs that he himself saw. "Apud Herodotum," says Cicero, "sunt innumerabiles fabulæ." But the inaccuracies of Herodotus are no ground for rejecting an eclipse described by Thucydides, who expressly tells us that he noted down events at the time that they occurred. Again, in the case of inscriptions at Babylon and Nineveh, it seems probable that total eclipses alone would be recorded. Partial eclipses are not particularly rare or impressive phenomena, and in the case of the eclipse of —1062, the words "fire in the midst of heaven" seem conclusive. The poet Archilochus, too, may be credited with having described what he saw. Again, as Tertullian considered the eclipse he refers to supernatural, it may be inferred that he would have supposed its theological significance reduced almost to zero if it had fallen far short of totality.

The evidence that I have made use of is therefore, I believe, in every case the evidence of eye-witnesses; but the *a priori* arguments I consider to be completely overshadowed by the *a posteriori* ones. For I have found that the same two correc-

Sup. 1905. *Sir C. Todd, Annular Eclipse, 1905 March 6.* 869

tions satisfy the equations of condition for five eclipses, and that one of these corrections is further supported by Mr. Nevill's amendment (*Monthly Notices*, vol. xxxix.) to Professor Newcomb's discussion of ancient lunar eclipses. If the eclipses were total, the numerical values of my corrections are correct; if the eclipses were partial, then the amazing accident must have occurred that all five are such that they can be rendered tabularly total by the same alterations of the tables.

The Annular Eclipse, 1905 March 6, observed in South Australia.
Communicated by Sir Charles Todd, K.C.M.G., F.R.S.

The conditions for observing the recent partial eclipse of the Sun in South Australia were extremely favourable. As shown in the *Nautical Almanac*, the central line entered the Australian continent at the head of the Great Bight, and emerged on the East Coast about lat. $22^{\circ} 50'$, passing therefore through our sparsely settled interior. In Adelaide the magnitude of the eclipse was 0.827 ; at Cradock (lat. $32^{\circ} 5'$) the observer says the annulus was almost discernible at mid-phase. I was unfortunately away in Melbourne, but Mr. Griffiths made very careful observations and furnishes the following notes.

"The eclipse was observed under very good atmospheric conditions. The first contact was noted at $1^{\text{h}} 51^{\text{m}} 52^{\text{s}}.9$ standard time, or $1^{\text{h}} 36^{\text{m}} 13^{\text{s}}.2$ Adelaide mean time. This is probably within a second or two of the real time, as I was looking at the exact spot: the limb was beautifully defined, and the merest indentation was observed. There were two large groups of spots on the Sun visible to the naked eye, one on the western side and the other in the eastern hemisphere. The Moon reached the western group at $2^{\text{h}} 14^{\text{m}} 37^{\text{s}}.9$, or $1^{\text{h}} 58^{\text{m}} 58^{\text{s}}.2$ A.M.T., and finally covered it at $2^{\text{h}} 23^{\text{m}} 25^{\text{s}}.8$, or $2^{\text{h}} 7^{\text{m}} 46^{\text{s}}.1$ A.M.T.; the second or larger group was reached at $2^{\text{h}} 58^{\text{m}} 5^{\text{s}}.4$ ($2^{\text{h}} 42^{\text{m}} 25^{\text{s}}.7$ A.M.T.), and finally covered at $3^{\text{h}} 9^{\text{m}} 43^{\text{s}}.4$ ($2^{\text{h}} 54^{\text{m}} 3^{\text{s}}.7$ A.M.T.) The definition was at times perfect, and the most careful scrutiny of the spots as they passed behind the Moon failed to reveal any distortion or change in their appearance: the colour of their umbræ seemed to be decidedly lighter in tone than the black Moon. The final contact was noted at $4^{\text{h}} 54^{\text{m}} 26^{\text{s}}.1$, or $4^{\text{h}} 38^{\text{m}} 46^{\text{s}}.4$ A.M.T., and was very exact, the limb being steady.'

Taking the time of final contact, Captain Lee, the Superintendent of Prince Alfred Sailors' Home, Port Adelaide, made the longitude of the Observatory $9^{\text{h}} 14^{\text{m}} 15^{\text{s}}.3$, the adopted longitude from a number of observations and comparisons with Melbourne and Sydney Observatories being $9^{\text{h}} 14^{\text{m}} 20^{\text{s}}.3$, an excellent result from a single observation.

The following temperature observations were made at the Observatory.